Research Paper | Engineering | E-ISSN No : 2454-9916 | Volume : 3 | Issue : 6 | June 2017

WIRELESS SENSORS APPLICATION FOR CONTROLLING OF CROP FIELD PARAMETERS

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ABSTRACT

Present day Soil monitoring systems make use of PC based servers and it is needed to interface the appliances to these PCs for the purpose of monitoring and controlling the governed parameters. Among the different technologies for crop monitoring, Wireless Sensor Networks (WSNs) are recognized as a powerful one to collect and process data in the agricultural domain with low-cost and low-energy consumption. Agriculture and farming is one of the industries which have recently diverted their attention to WSN, seeking this cost effective technology to improve its production and enhance agriculture yield standard. The proposed system is hardware as well as software based which will automatically control the parameters of the soil. Further the system is expected to determine the environmental value and then after classifying, it needs to decide which action to be performed for controlling. The action to be performed for controlling the environment depends on the threshold value.

KEYWORDS: Wireless sensor networks, Precision agriculture; Crop monitoring, Environment monitoring, Communication technologies.

1. Introduction

Soil monitoring is the process of collection of soil and testing in laboratory or at field by analytical methods. Soil monitoring system is used to sustain the quality of soil which can be used to evaluate whether soil quality is being degraded, improved or maintained. Applying wireless sensor networks for monitoring environmental parameters and combining this information with a user-customized web service may enable farmers to exploit their knowledge in an efficient way in order to extract the best results from their agricultural cultivation. In recent time, the wireless sensor network technology has found its implementation in precision agriculture as a result of the need for increasing production rate. The diversity of location and climatic effects upon agricultural cultivation, along with other environmental parameters over time makes the farmer's decision-making process more complicated and requires additional empirical knowledge. [1] - [3]. There is a considerable increasing growth in the field of Information and Communication Technology in Developing Countries. During the previous decade, environmental monitoring by using sensor networks has received considerable attention. The agriculture is in the transition from traditional agriculture to modern agriculture currently [1], [3]-[6]. The challenges for controlling and monitoring of environment are mentioned below:

1.1 Scope of the project

The proposed system is hardware as well as software based which will automatically control the parameters of the soil. The data will be transferred over the Internet using the Wi-Fi modem. The scope of the project can be extended to varied areas ranging from greenhouse environment, power plants, chemical industry, and medical production to home automation, but for the time being system is just implemented for the soil parameters management. Our project motto is to achieve two main applications as monitoring and controlling of crop field parameters.

2. Literature Review

Sensor networks were developed by the United States during the Cold War to detect and track Soviet submarines. A system of acoustic sensors called the Sound Surveillance System (SOSUS) was placed at strategic locations on the bottom of the ocean. Around the same time the United States also deployed a network of radars for air defense. [2], [8]. It was called the Distributed Sensor Networks (DSN) program where many low-cost sensing nodes were spatially distributed and they processed data collaboratively [5], [7]. A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, humidity, motion or pollutants and to cooperatively pass their data through the network to a main location. A wireless sensor network (WSN) is a network formed by a large number of sensor nodes where each node is equipped with a sensor to detect physical phenomena such as light, heat, pressure, etc. WSNs are regarded as a revolutionary information gathering method to build the information and communication system which will greatly improve the reliability and efficiency of infrastructure systems [8]-[11].

2.1. Agriculture and Wireless Sensors

In precision agriculture (PA), various parameters including soil type and temperature vary dramatically from one region to the other; consequently, any irrigation system must be flexible to adapt to such variations. Off-the-shelf irrigation controllers are usually expensive and not effective in managing scarce water resources. On the other hand, an irrigation management system (IMS) based on wireless sensor networks (WSNs) can accept any desired irrigation scheduling strategy to meet specific environmental requirements. Wireless Sensor networks can be used for monitoring spatio-temporal changes in climate, hydrology, pressure, motion, soil moisture, plant eco-physiology, pests and reporting best options to the agriculturist. [7], [12], [13]. Microplitis Croceipes, a tiny parasitoid wasp, locates caterpillars attacking cotton plants by keying on a complex volatile organic cocktail emitted from the plant when attacked. Thus sensors capable of detecting this cocktail would result in early detection and mitigation of these attacks by highly selective pesticide applications or wasp introductions [5], [13]-[16].However, WSNs are still under a developmental stage; as such, they are at times unreliable, fragile, and power hungry and can easily lose communication especially when deployed in a harsh environment like an agricultural field [13], [17], [18].

The effectiveness of precision agriculture is based on the analysis of accurate sets of measurements in soft real-time. Parameters such as the soil condition and humidity are aggregated and analyzed, in order to extract useful information that a farmer can use as a recommendation or guidance; or even to apply fully automated procedures to the crop cultivation process chain [1]-[3], [17], [18].In Precision-Agriculture field variations are monitored, stored for managing and maintaining the precious resources using technologies to manage and improve production or yield. This can be the tool at the hands of agriculturists for management with goal of optimizing return on investments while preserving natural resources. Precision Agriculture deals and takes care of viz. three branches of science [13], [18], [21].

2.2. Monitoring of Environment

Environment Monitoring (EM) plays a key-role to show the effects of human behavior on the environment and to disclose its limits. Typical applications, in addition to purely environmental science purposes, include the protection of water supplies, radioactive waste treatment, air pollution monitoring, natural resource protection, weather forecasting and enumeration and monitoring of species. Environmental Monitoring strives to determine the status of a changing environment by analyzing a representative sample of the environment. Environmental monitoring describes the processes and activities that need to take place to characterize and monitor the quality of the environment. The foundation of EM is the collection of data, which enables a better understanding of our natural surroundings to be gained by means of observation. Environmental Monitoring is not limited to the understanding of environments, but also includes monitoring for preservation reasons. The environmental parameters, such as temperature, humidity, water seepage of ground, etc. are the key factors of substations in electric networks [1]-[3], [11], [18]. The manual inspection is still used in many sub-

stations in India. Such traditional method exposes evident disadvantages:
1) Time-consuming since the wide distribution of substations; 2) No timeliness of failure discovery; 3) Carelessness of inspectors

2.3. Agricultural Water Management

Water consumption around the globe has increased seven times in the course of the last century. The level of ground water is declining. It is know that 1.1 billion people across the world live without satisfactory access to clean water. This results in the death of roughly 2 million people per year due to lack of water related diseases. Political stability itself is at risk, as experts predict that upcoming conflicts are most probably about water resources. As water supplies became scarcer, there is the need to manage water consumption. Water consumption has increased dramatically in the past decade [3]. Water is a precious resource, it is also considered as a source of conflict among nations. The parameters involved in the water reservation control such as the water level and motor movement of the gate controlling the flow of water will be measured in the real time by the sensors that send the data to the base station or control/ monitoring room [6, 8, 13, 25].

3. Methodology

It deals with hardware and software implementation followed by block diagrams and procedure of experimentation

3.1. Hardware and Software Implementation

Minimum hardware and software needed to implement the specified requirements are power supply, temperature sensor, soil sensor, gas sensor, rpi board, relay driver, Wi-Fi modem and pc. Components required for interfacing are DS18B20 (temperature sensor) , 4.7kΩ resistor (Pull Up), breadboard (Half Size) and connecting wires, Solder and a soldering iron, raspberry Pi board. Software required are Linux, Debian, Raspbian, Python and Putty. Linux is basically a kernel. It is the basic software which gives low-level access to equipment. With help of this we can perform errands likewise transferring of information over the system, displaying graphical images, sound yields, beginning & halting programs, perusing & composing records and so on. Debian is a free working framework (OS) for your PC and incorporates the fundamental arrangement of projects and utilities that make your PC keep running alongside numerous a huge numbers of different bundles. Raspbian is informal port of Debian wheezy armhf with arrangement settings altered to generate a code that utilizes "hardware floating point", the "hard float" ABI and work on the RPi. The port is important on the grounds that the authority Debian wheezy armhf release is good just with forms of the ARM architecture later than the one utilizes on the Raspberry Pi. Putty is utilized to enter into Raspberry Pi module. It is a free and open-source terminal emulator, serial console and files exchange trade application. It reinforces a few framework traditions, including SCP, SSH, Telnet, rlogin, and crude attachment affiliation. It can in like manner interface with a serial port. Python is an intelligent translator and object oriented programming language. It joins modules, exemptions, dynamic writing, high end dynamic information sorts, and classes. Python is a strong language which also provides clear linguistic structure. It has interfaces to numerous framework calls and libraries, different window frameworks, and is extensible in C or C++.

3.2. Procedure of Setup

First connect pin no 1 of the DS18B20 to the ground GPIO pin. Secondly connect pin no 2 of the DS18B20 to the GPIO pin 4,then connect pin no 3 of the DS18B20 to the 3.3V GPIO pin, now connect resistor of 4.7kΩ in-between pin no 2 and pin no 3 of the DS18B20.Now turn on the Pi. If by mistake anything goes wrong while wiring then u can come to know about it just by touching the sensor. With wrong wiring sensor gets heats up in 1-2 seconds. In such case switch off the Pi and let the Sensor cool down for some time and once it is chilled off then re interface it with the Pi. After Setup following are the steps to be performed.

- Connect system with WIFI
- Provide Power supply to Raspberry-Pi
- Identifying the IP address of Raspberry-Pi (Command Line/Fing App)
- Open the Putty Software
- Enter the IP address of the Raspberry-Pi
- Open Command Line Window
- Enter the user name and password
- Change the access permission
- Open the Nano File
- Access the data through Web by opening Google Chrome
- Enter the IP address in tab
- Enter the user name and password
- Final Output will be displayed
- Open the Command line and enter power off
- System will shut-down

Respective block diagrams of sensors used are shown below. The one wire Digital Temperature Sensor - DS18B20 from Maxim (in the past Dallas) is an incredible chip for measuring temperature in your undertakings. This sensor utilizes One Wire convention. You require just a Raspberry-Pi board, a DS18B20 with a 4.7KOhm resistor. The DS18B20 can be controlled by somewhere around 3.0V and 5.5 V so you can just interface its GND pin to 0V and the VDD pin to +5V from the Raspberry Pi. However, the DS18B20 can sink its required energy from the data line which implies we just successfully require two wires to associate it up. This makes it awesome for use as an external sensor. The moisture sensor board features both analogue and digital outputs. The analogue output gives a variable voltage reading that allows you to estimate the moisture content of the soil. The digital output gives you a simple "on" or "off" when the soil moisture content is above a certain value. The value can be set or calibrated using the adjustable on board potentiometer. A gas sensor recognizes the existence of gasses in a particular zone, regularly for security purpose. It is utilized to identify a gas leak and inform the same to the controlling device so that the system can be shut down immediately. This gas sensor can also send the signal to alarm causing it to ring in the territory where the leakage is taking place. It gives the workers a chance to leave the premises before getting adversely affected by the dangerous gasses. This sensor is vital as it can save many lives of human beings as well as animals because there are many gases that can be destructive.

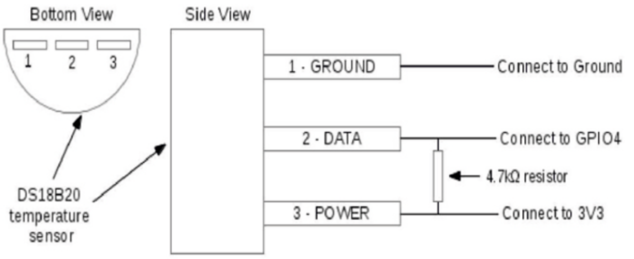

Figure 1 Block diagram of temperature sensor

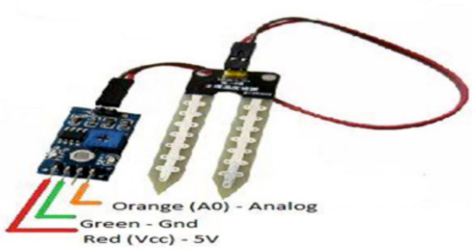

Figure 2 Soil sensor

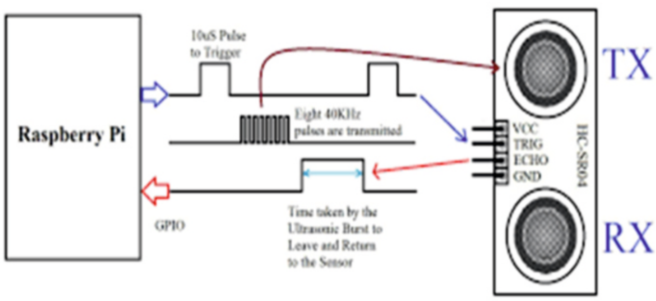

Figure 3 Soil sensor with raspberry pi

Figure 4 MQ2 gas sensor

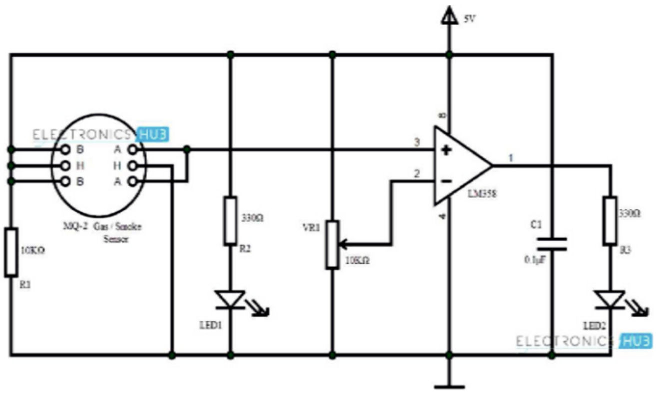

Figure 5 Interfacing of raspberry Pi with Mq2

The output of the sensor goes to the analog to digital converter. This converter changes this analog signal from the gas sensor into a digital signal, which is the main sort of signal that the Raspberry pi can decipher

3.3. Block Diagram

The Block diagram shows the activity performed during the course of the project. The activity performed in the project starts with monitoring of the soil and environment parameters such as Soil Ph, Temperature and Gas. The monitored value in digital format is given to RPI. If temperature, soil Ph and Gas increases or decreases with respect to the threshold value, the system will perform controlling operation directly. If they are equal to the threshold value it will simply just transfer the environmental values over the Web and message will be displayed.

As the acidity of the H+ in the soil increase the soil PH value decrease, Soils with PH value below 7 are referred to as “acidic” and those with PH values above 7 as “alkaline”, the system will perform controlling operation directly such as water sprinkler will start to increase or decrease PH level of soil. If Temperature of the environment is above room temperature then Fan will turn ON else it will be OFF. If more oxygen level of gas gets sensed then buzzer will turn ON and message will displayed as “Aerobic soil environment”. Similarly if less oxygen level of gas gets sensed then buzzer will turn OFF and message will displayed as “Anaerobic soil environment.

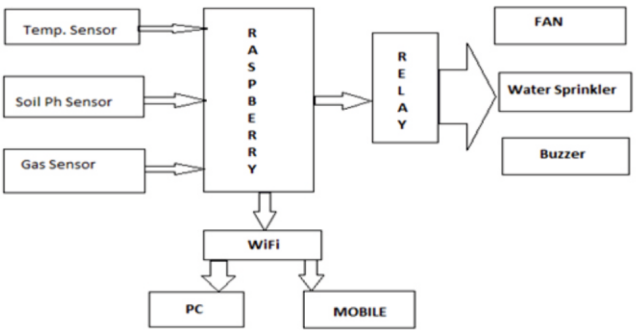

Figure 6 Block diagram of data acquisition system for remote monitoring and controlling of soil environmental parameters.

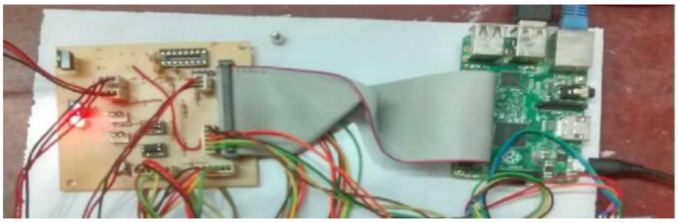

Figure 7 Hardware design

4. Results

When temperature is below room temperature, Soil pH is less than threshold value (i.e. below 7) then soil is acidic and more oxygen get sensed, soil is aerobic. When temperature is above room temperature, Soil pH is greater than threshold value (i.e. above 7) then soil is alkaline and less oxygen get sensed, soil is anaerobic. Results are shown below in table and one sample of screen shown is shown with respect to web page display.

4.1. Web page Display

When temperature is below room temperature, Soil pH is less than threshold value (i.e. below 7) then soil is acidic and more oxygen get sensed, soil is aerobic. When temperature is above room temperature, Soil pH is greater than threshold value (i.e. above 7) then soil is alkaline and less oxygen get sensed, soil is anaerobic. Following are the screen shots of sample readings.

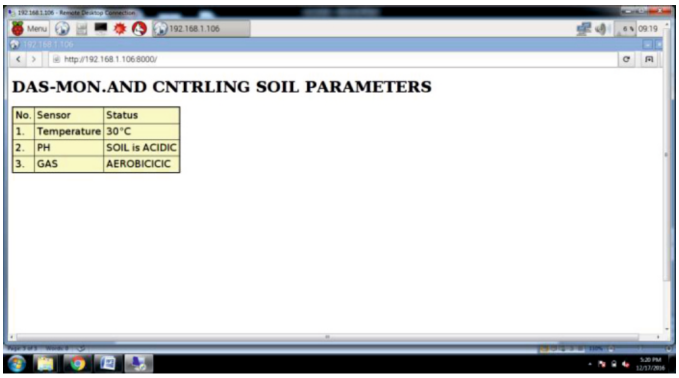

Figure 8 Screen shot 1

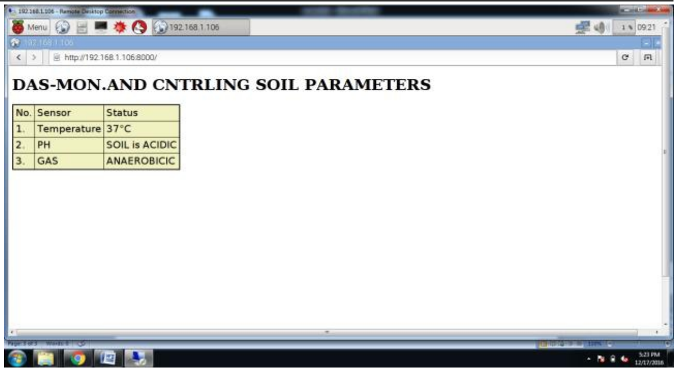

Figure 9 Screen shot 2

5. Conclusions & Discussion

"Embedded Web Server" is new technology which can be used for monitoring and controlling parameters. This technology facilitates the monitoring and controlling of parameters remotely with the help of raspberry pi and IOT. This system is inexpensive, scalable, and highly efficient and it also provides fast response. As it uses a low powered raspberry pi board and different low powered sensors, it helps to atomize the industry in less cost and less energy which decreases overall cost of the atomization.

6. Future Scope

From the literature studied, scope for future study will be

- To add successfully pest control mechanism for better yield based on detail study of respective pest control mechanism.
- Grouping of similar types of crops and implementing general type of cop monitoring system.

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